

Amphenol

INTERCONNECT AND VALUE ADDED SOLUTIONS BY DESIGN

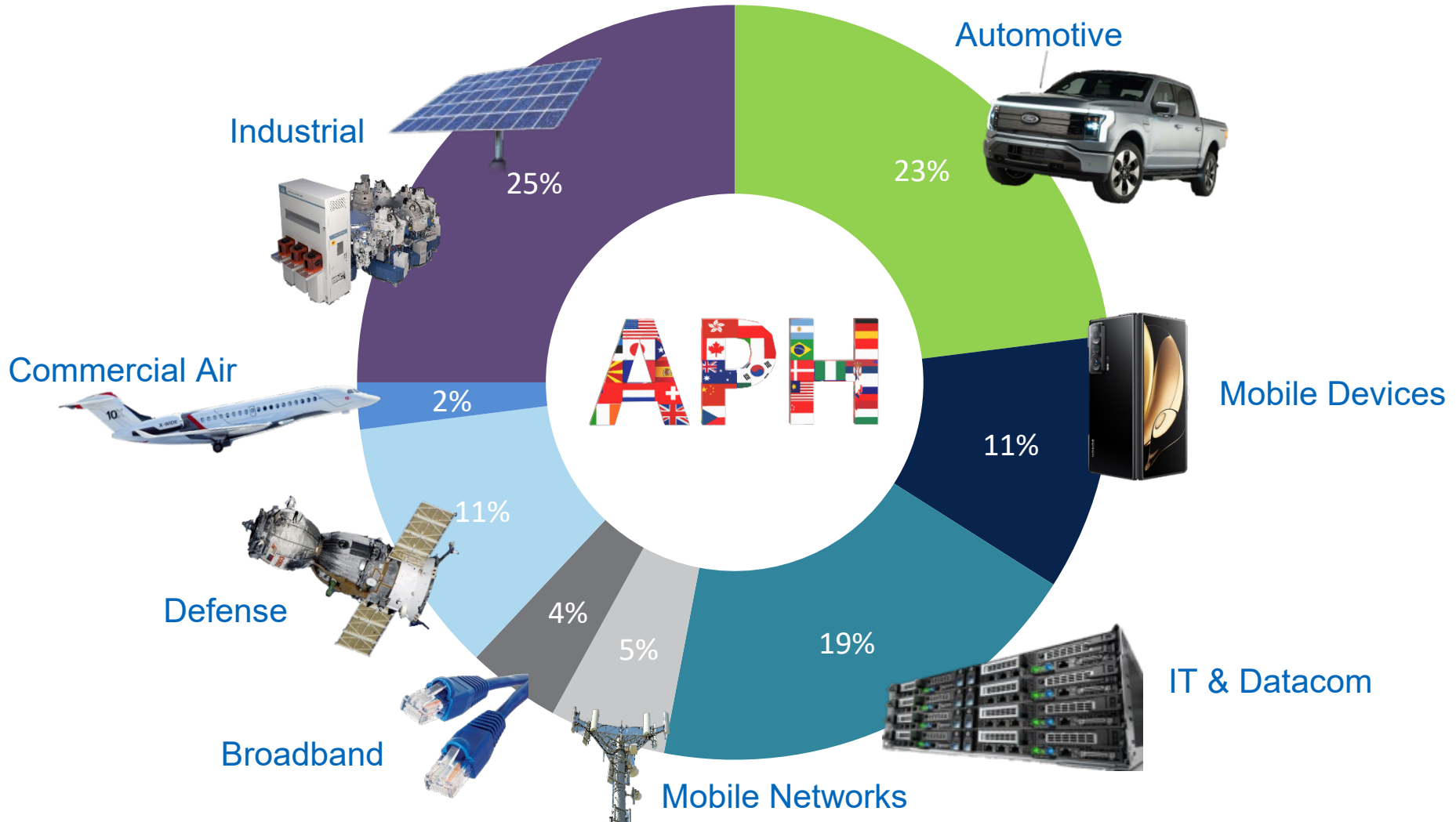
Electrification at Amphenol

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Global Leaders in Interconnect & Sensing Technology in Various Markets



Vehicle Electrification Portfolio

LOW AND HIGH VOLTAGE CONNECTIONS
FT. RADSOK® CONTACT TECHNOLOGY



AUXILIARY HV/LV
CONNECTIONS



TRANSMISSION
CONNECTIONS



PASS-THROUGH



BATTERY SWAP MODULES (BSM)



BATTERY PACK



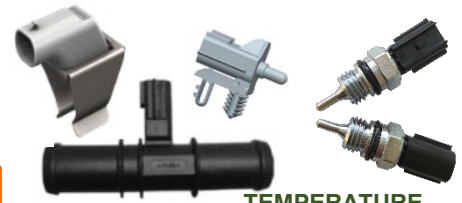
POWER
DISTRIBUTION
UNIT



MOTOR
CONTROL UNIT



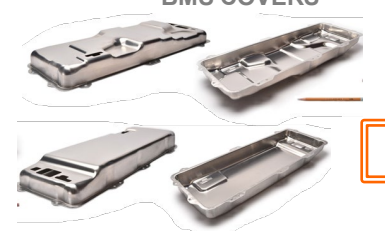
TEMPERATURE
SENSING



THERMAL
RUNAWAY
DETECTION



BMS COVERS



DC/DC



CHARGER



MOTOR



SPEED AND POSITION
SENSING



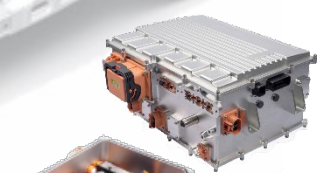
PRESSURE AND P/T
COMBINED SENSING



BATTERY FLEX AND
THERMISTOR HARNESS



PDU



ROTOR POSITION SENSOR (Resolver alternative)



CABLE ASSEMBLY



CCS1, NACS, etc
CHARGING



DC/AC BIDIRECTIONAL
INVERTERS



RIGID AND FLEXIBLE BUSBARS



COOLANT LEAK SENSOR



Vehicle Portfolio Beyond E-Mobility

Interior & Comfort

- ▶ Ambient / Interior lighting
- ▶ Interior mirror / Sensors (Rain, dew, sun load.)
- ▶ HVAC sensors and harness
- ▶ Camera systems
- ▶ Connectivity: HSD / Ethernet / FAKRA
- ▶ Electronics components – B2B / B2W / IO

Multimedia / Infotainment

- ▶ Data connectivity and components
- ▶ Data wire harnessing
- ▶ Media Hubs

Power Electronics / Power supply

- ▶ DC-DC Inverters / DC-AC Converters
- ▶ OBC, Power Management
- ▶ Smart Switches / Fuses
- ▶ Fuse box, pre fuse systems, Current sensors

Power train & Transmission systems

- ▶ DCT dual clutch transmission
- ▶ internal gearbox harnessing
- ▶ temperature & pressure sensors

Steering

- ▶ electronic steering
- ▶ Steering wheel harness
- ▶ Horn switch

Climate and heating HVAC

- ▶ air condition systems
- ▶ auxiliary heating systems
- ▶ Sensors

Exterior Lighting

- ▶ Bulb sockets and connectors
- ▶ Exterior Lighting harness
- ▶ Functional lights
- ▶ CHMSL / Position lighting
- ▶ Pre field illumination

Motor & Aggregates

- ▶ engine cooling
- ▶ fuel handling devices
- ▶ windscreen washer system
- ▶ engine cooling systems
- ▶ hybrid applications

Doors / Mirrors

- ▶ Power window motors
- ▶ Door handle switch
- ▶ Remote Entry Antenna
- ▶ Central locking systems
- ▶ Mirror connections - harness

Chassis

- ▶ Active Body Control
- ▶ Smart Carpet
- ▶ Shock absorber adjustment
- ▶ Rear axle steering
- ▶ Active Suspension

eMobility – EV Battery

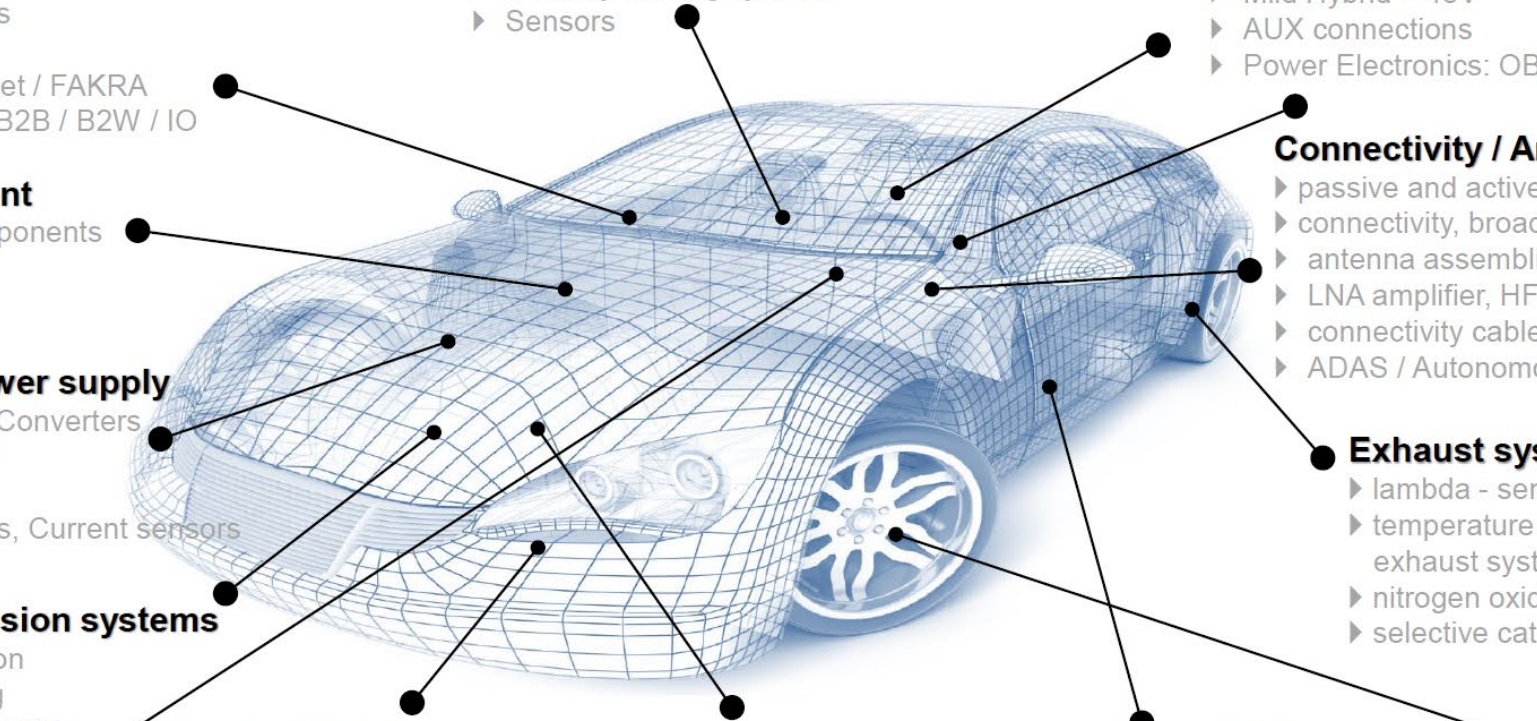
- ▶ HV components and Harness
- ▶ EV Battery IO Components MSD, Bus Bars,
- ▶ Transmission interface and solution
- ▶ Mild Hybrid – 48V
- ▶ AUX connections
- ▶ Power Electronics: OBC, DC-DC DC-AC

Connectivity / Antennas

- ▶ passive and active antennas
- ▶ connectivity, broadcast, radio, low frequency C2C
- ▶ antenna assemblies with coax FAKRA cable
- ▶ LNA amplifier, HF switches
- ▶ connectivity cable assy. Ethernet / FAKRA / HSD
- ▶ ADAS / Autonomous Driving

Exhaust systems

- ▶ lambda - sensors
- ▶ temperature sensors for exhaust systems
- ▶ nitrogen oxide-emission sensors (NOx)
- ▶ selective catalytic reduction (SCR) / AdBlue

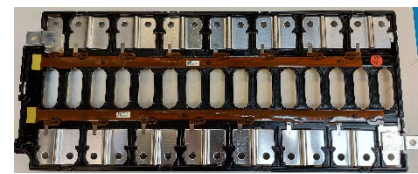


ESS Portfolio

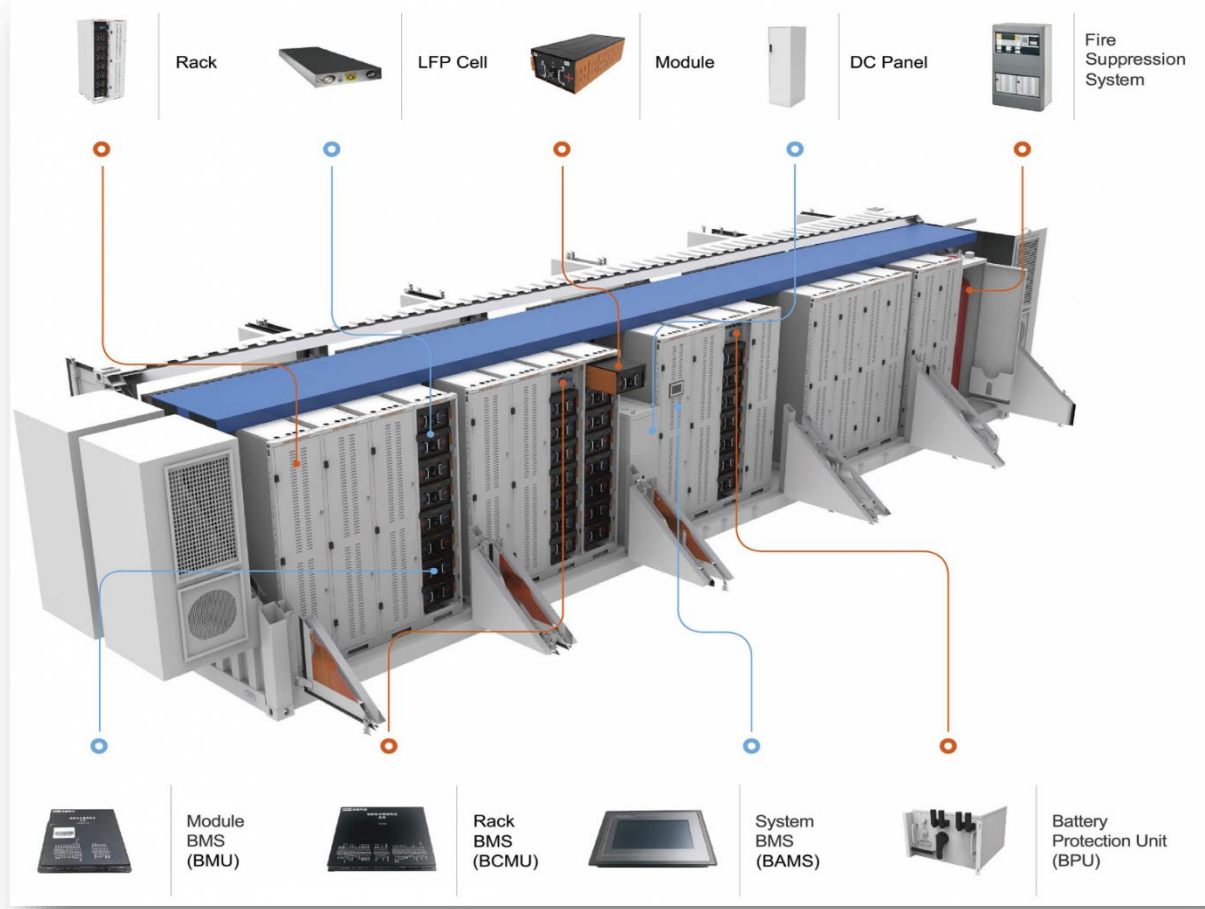
HV connectors & assemblies



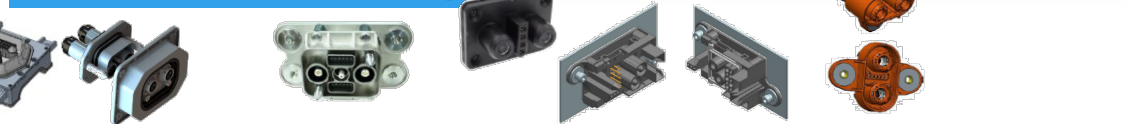
Cell connection systems



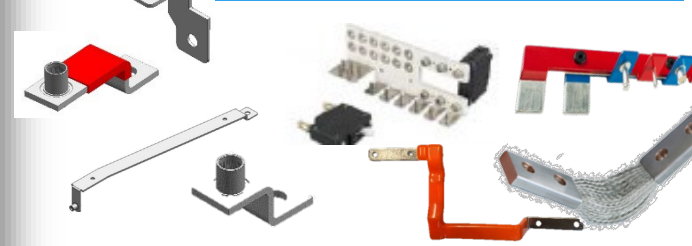
Blind mate



Battery Swap Modules



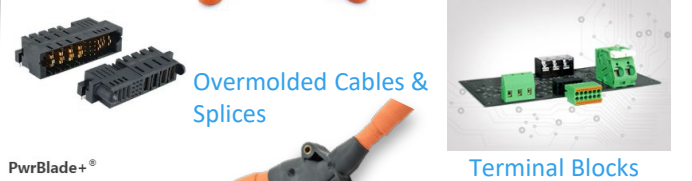
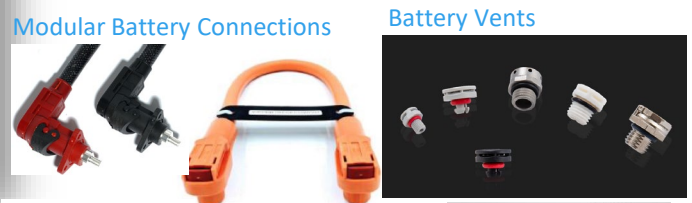
Busbars



Sensors



Other



Amphenol Sensor Portfolio

Delivering Value-Add  Sensors



Critical Electrification Sensors

Battery:

- Busbar, Cell Temperature
- Cold plate temperature
- Connector temperature
- Water intrusion/coolant breach
- Early Thermal Runaway Detection (REDTR)
- Cell connection systems
- Current



Inverter:

- Inverter temperature
- Current

Thermal Management:

- Coolant Temperature, Pressure
- Refrigerant Temperature
- Refrigerant Pressure/Temperature
- Evaporator Temperature
- Position sensors
- Coolant level Sensors



Charger:

- HV component temperature
- Connector temperature
- Water intrusion/coolant breach
- HV Busbars, cabling, and connectors
- Communications antennae
- Cable & Connector temperature sensors
- Lock position, access door open/closed
- EVSE weather station
- Adapter temperature (x2)
- Current

THERMAL RUNAWAY DETECTION

Temperature Sensors

Measure and monitor battery temperature to detect Thermal Runaway conditions.

- Capable of single or multiple cell detection



Pressure Sensors

Detect pressure change inside the battery cell that indicates Thermal Runaway conditions.

- Surface mountable
- Simple 3-command I²C interface
- Very low current consumption: <35µA



Gas Detection Sensors

Detect the out-gassing of Carbon Dioxide (CO₂) to indicate pre-combustion conditions.

- Single and dual channel configurations
- Self-calibration with patented ABC Logio™ Software



Gas Detection Sensors

Detect the presence of combustible gases that indicate Thermal Runaway conditions.

- Sensitive to multiple gases: H₂ / CH₄ / CO₂
- Fast response time: <10 seconds
- IP6K7 rating



BATTERY PACK

Temperature Sensors

Measure and monitor surface temperature of the many batteries within the battery cell, which is critical to preserving the chemistry of the battery.

- Single point temperature sensors
- Rigid and flexible types
- Custom sensor packaging



CELL CONNECTION SYSTEM (CCS)

Temperature Sensors

Provide temperature and voltage sensing to monitor the state of charge of the battery cells.

- High current circuit for battery cell connectivity
- Available styles:



Wire Harness and Flexible Printed Circuit (FPC)

HIGH VOLTAGE CHARGER CONNECTOR

Temperature Sensors

Detect over-temperature conditions during charging.

- Installed within the connector



BATTERY COOLANT

Temperature Sensors

Measure and monitor fluid temperature of inlet/outlet battery coolant to provide indication of battery cell temperature.

- No leak path - Sensor cavity and tube are one piece
- USCAR sealed connection system
- Many part geometries:



Pressure Sensors

Measure the pressure in the cooling system to control pump capacity.

- Internal metal sealing for high media compatibility and no leakage
- Customized calibration for high accuracy



Combined Pressure & Temperature Sensors

Measure pressure in the cooling system, while, at the same time, measure temperature of the coolant for optimum thermal management.

- Available versions: R1234yf (up to 35bar) and R744 (up to 200bar)
- Tested LIN 2.1 conformity
- Automatic address assignment within LIN network (Slave Node Position Detection)



Ultrasonic Level & Temperature Sensors

Continuously monitor fluid level for early detection of coolant leakage.

- Level accuracy: ±2mm
- Temperature accuracy: ±2.5°C
- Output protocol offerings: Analog, PWM, SENT, CAN, LIN
- Input voltage options: 5V / 12V / 48V



MOTOR COIL

Temperature Sensors

Measure and monitor temperature of the motor coil to provide feedback on the operating conditions of the electric motor.

- Field-proven design
- Variety of lead lengths, terminal and connector options



POWER INVERTER / E-MOTOR

Temperature Sensors

Measure and monitor operating temperature of the power inverter to provide feedback on unsafe conditions.

- Fast response time
- Pigtail connector



Inductive Position Sensors

Provide data on the angular position of the rotating motor shaft to optimize control of the motor inverter.

- Inductive eddy-current with weight and size reduction
- Stable output over extended temperature range (-40°C/+160°C) and radial/axial misalignment
- Robust against magnetic flux and external stray fields



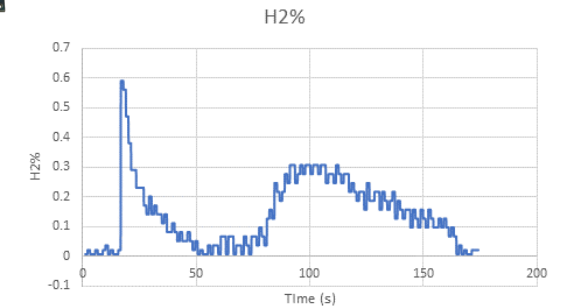
Robust Early Detection (RED) of Cell Venting

Multiphysics-based monitoring sensor platforms to detect cell venting failure

- Mobile Battery systems (passcar, HVOR, micromobility)
- Stationary Storage applications
- Battery transport and storage

Content and Features:

- Gas sensors: H₂, CO₂, CO, VOC's
- Additional sensors: temperature, relative humidity, pressure
- Communications: CAN, RS485, TCP/IP
- >20 year design life
- Can monitor single v cascade events
- Tested by NHTSA, DoE, JRC, major manufacturers
- Samples available



Cylindrical cell TR in 20 000 liter ISO container

Robust Early Detection of cell failure venting for a broad range of applications

High Voltage Device Temperature sensing – ZTP infrared sensor

For monitoring critical HV components: FETs, connections, bus work

An infrared thermometer is a thermometer which infers temperature from a portion of the thermal radiation sometimes called black-body radiation emitted by the object being measured.

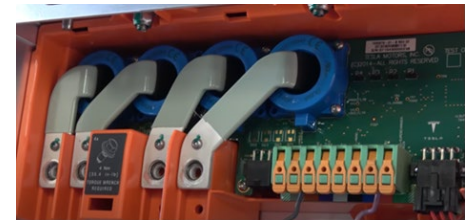
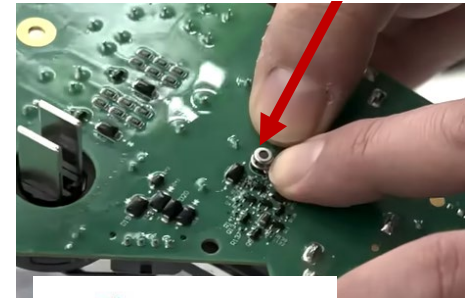
Infrared temperature sensing for fast and accurate monitoring of HV components:

- Meet IEC 60664 Clearance requirements with a non-contact temperature monitoring approach
- Accurate over distances
- Eliminate risk of dielectric breakdown of sensor insulation for HV components
- ~20 millisecond time response
- Digital “Plug and play” installation
- -40C to 125C device temperature
- -40 to 200C object temperature with 1 deg C accuracy

Typical applications:

- HV connections, such as charger-to-wire and interconnects
- HV bus temperature
- HV SiC MOSFETs and other inverter components

Parameter	Limits			Units	Condition
	Min	Typ	Max		
Chip Size	1.8 x 1.8			mm ²	
Diaphragm Size	1.0 x 1.0			mm ²	
Active Area	0.5 x 0.5			mm ²	
Internal Resistance	35	50	65	kΩ	25°C
Resistance T.C				0.15	%/°C
Responsivity	42	60	78	V/W	500K, 1 Hz
Responsivity T.C				-0.10	%/°C
Noise Voltage	30			nV rms	R.M.S., 25°C
NEP	0.50			nW/Hz ^{1/2}	500K, 1 Hz
Detectivity	1.00 E08			cmHz ^{1/2} /W	500K, 1 Hz
Time Constant	20			ms	



Fast, high accuracy non-contact temperature monitoring of HV components

EVSE Portfolio

EV Charging Plug and Inlets



- GB/T**
- AC up to 80A
 - DC +500A
 - Combo Inlet Optional



- CCS1 SAE DCFC**
- AC up to 80A UL
 - DC up to 350A UL
 - HPC DC up to +500A UL
 - Inlet up to 150mm² (500A)



- CCS2 IEC DCFC**
- AC up to 63A (1 or 3 Phases)
 - DC up to 400A IEC
 - HPC DC +500A IEC
 - Inlet up to 150mm² (500A)



- MCS**
- Level 1 +350A
 - Level 2 +1000A
 - Level 3, 3000A
 - 1250V



- AC SAE J1772**
- AC up to 60A UL
 - DC up to 350A UL
 - HPC DC up to +500A UL
 - Inlet up to 150mm² (500A)

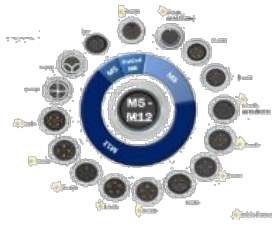


- AC IEC**
- AC up to 63A (1 or 3 Phases)
 - DC up to 400A IEC
 - HPC DC +500A IEC
 - Inlet up to 150mm² (500A)

RADSOK POWER



INSTRUMENTATION CONNECTORS



ANTENNAS



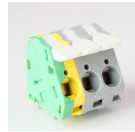
IoT MODULES



Splices



Blind Mate Connectors



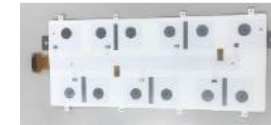
Terminal Blocks



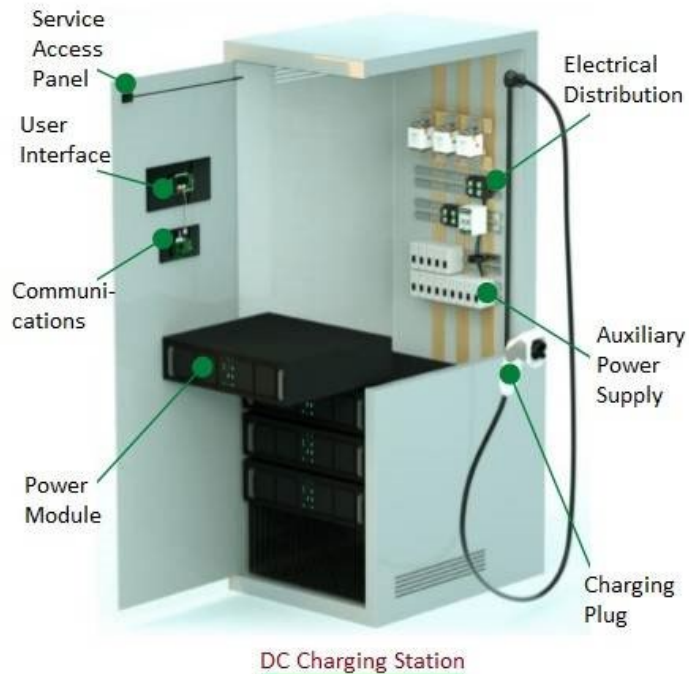
MANUAL
SERVICEDISCONN
ECT



RIGID AND FLEXIBLE BUSBARS



LAMINATED BUSBARS



DC Charging Station



PRESSURE AND P/T
COMBINED SENSING



CURRENT SENSOR



IRSENSOR

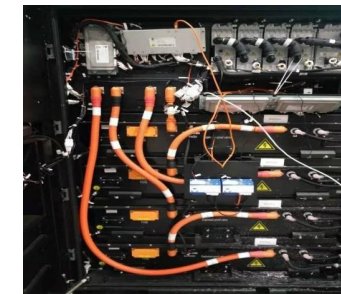


COOLANT LEAK SENSOR



TEMPERATURE SENSING

LOW AND HIGH VOLTAGE CONNECTIONS FT. RADSOK®



EV Charging : Plugs & Inlets

MCS	CCS1 UL	AC SAE J1772	CCS2 IEC	IEC AC	GB/T
 <p>MCS LVL 1 Passive +350A</p>	 <p>CCS1 Plug HPC LCC 500A</p>	 <p>AC SAE Plug 16A to 80A</p>	 <p>CCS2 Plug HPC LCC 500A</p>	 <p>IEC Plug 16A to 80A</p>	<div style="display: flex; justify-content: space-around;"> <div>  <p>AC</p> </div> <div>  <p>DC</p> </div> </div>
 <p>MCS LCC Liquid Cooled LVL 2 1000A LVL 3 3000A</p>	 <p>CCS1 Copper 125A -350A</p>	 <p>AC SAE - CAC 32A</p>	 <p>CCS2 Copper 125A -400A</p>	 <p>IEC Jumper 16A to 80A</p>	 <p>GBT HPC LCC 600A</p>
 <p>MCS Inlet Passive LVL 2 1000A</p>	 <p>CCS1 light 40A-65A-80A</p>	 <p>AC SAE Portable Mode 1 16A to 32A</p>	 <p>CCS2 light 40A-65A-80A</p>	 <p>IEC Jumper 16A to 80A</p>	 <p>GBT DC 80A to 250A</p>
 <p>MCS Inlet Liquid Cooled LVL 3 3000A</p>	 <p>CCS1 Inlet 65A - 500A</p>	 <p>AC SAE Inlet 16A to 80A</p>	 <p>CCS2 Inlet 65A - 500A</p>	 <p>IEC AC Portable Mode 1 16A to 32A</p>	 <p>GB/T Combo Inlet</p>
 <p>GB/T Inlet AC or DC</p>					

★ Work in Progress 2022
 ★ Work in Progress 2023 Q1/Q2